

The San Andreas Fault System in Central California as the Boundary between the Pacific Plate and the Sierra Nevada-Great Valley Microplate: Kinematics from VLBI Geodesy

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The San Andreas Fault (SAF) system in California is often considered to be the boundary between the Pacific and North American plates. Because of the considerable deformation that occurs east of the SAF, especially in the Great Basin, this concept has limited applicability. In central California, from the western Transverse Ranges to Cape Mendocino, the SAF system is more usefully interpreted as the plate boundary zone between the Pacific plate and the Sierra Nevada-Great Valley microplate [Argus & Gordon 1991]. Here we examine the tectonics of this plate boundary zone through the horizontal kinematics revealed by VLBI geodesy [Argus & Gordon 1993]. The tectonic implications of these results include the following:

(1) The motion of the Pacific plate relative to the microplate nearly parallels the straight segment of the SAF north of the big bend of the fault and south of Hollister, including the Carrizo and Parkfield segments. Convergence perpendicular to these segments is statistically insignificant and is limited to 3 mm/yr (95% limits).

(2) The speed of the Pacific plate relative to the microplate is 40–41 mm/yr, significantly greater than estimates of slip along the long straight segment of the SAF. Either these estimates are too low, or significant inelastic deformation occurs, or several mm/yr of strike-slip is taken up on other faults nearly parallel to the San Andreas fault.

(3) All creeping segments of faults in the SAF system are nearly parallel to the velocity of the Pacific plate relative to the microplate. Therefore a necessary condition for creep may be a negligible component of convergence across the fault segment.

(4) Locked zones mainly correspond to restraining trends as viewed in this framework (i.e., with strikes CCW of the local Pacific-microplate velocity). Thus, fault normal contraction and associated high components of normal stress may contribute to the creation of the asperities along the fault that accumulate strain released in great earthquakes.

(5) The San Andreas has significant restraining trends in the Santa Cruz Mountains and north of Pt. Reyes. The motion of Pt. Reyes parallels, or is modestly CW of, the Pacific-microplate velocity, which implies contraction across the San Andreas and Rodgers Creek Faults, which are both slightly CCW of plate motion. The velocity of Fort Ord, parallel or slightly CW of the plate velocity, implies large contractions across the SAF north of Hollister, as is manifested by the existence of the Santa Cruz Mountains.

(6) Near San Francisco, the San Andreas is locally parallel to Pacific-microplate velocity, as is the Hayward fault east of San Francisco Bay and the velocity of the Presidio. The Calaveras fault in the East Bay, however, has a dilatational trend relative to the Pacific-microplate velocity. Thus little, if any contraction is required by the fault strikes and plate velocity.

(7) The motion at Vandenberg AFB parallels the plate velocity and the trend of the nearest segment of the SAF, implying that motion of Vandenberg towards the Great Valley cannot explain any fault-perpendicular shortening observed there.